APPENDIX F-2: Groundwater Monitoring Plan for the St. Peter Sandstone (lowermost USDW)

Groundwater Monitoring Plan for the St. Peter Sandstone.
Illinois Industrial Carbon Capture & Sequestration (IL-ICCS) Project
Decatur, Illinois

F2.1. Purpose, Number of Wells, and Well Placement

The purpose of this plan is to monitor the St. Peter Sandstone, the lowermost underground source of drinking water (USDW), for any reservoir changes that may indicate leakage through the confining zone.

Geophysical Monitor #2 (GM#2) well will be used to monitor pressure within the St. Peter Sandstone.

Annual reservoir saturation tool (RST) logs will be performed in GM#2 to monitor for CO_2 saturation within the St. Peter Sandstone. Details about using RST logs for monitoring and identifying the presence of CO_2 is described in section 6A.2.5: Tracking Extent and Pressure of CO_2 Plume.

Annual RST surveys will be performed in Verification Well #2 (VW#2) to monitor for CO_2 saturation within the St. Peter Sandstone.

Annual RST surveys will also be performed in CCS#2 (injection well) to monitor for CO_2 saturation at the injection point and to determine the vertical profile of the CO_2 plume at the well bore.

The results from the RST surveys from all of the wells will be integrated into the reservoir simulation models.

Prior to injection, the operator will use GM#2 to obtain baseline samples of the formation fluid within the St. Peter Sandstone. The samples will be obtained using swabbing techniques and/or a downhole fluid sampler. Analysis of these samples will provide the formation's baseline reservoir fluid profile. The geochemical analysis methods for these samples are further described below.

After initiating injection, no additional direct fluid sampling of the St. Peter Sandstone is planned unless pressure and RST measurements show changes in the reservoir condition that indicate leakage through the confining zone.

F2.2. Sampling Parameters, Sampling Methods, and Analytical Methods

We propose to analyze St. Peter Sandstone groundwater samples for the following:

Field Parameters:

- pH
- Specific Conductance
- Temperature

Indicator Parameters:

- Alkalinity
- Bromide
- Calcium
- Chloride
- Sodium

All indicator parameters of interest are inorganic and have been selected based on known chemical reactions of CO_2 in aqueous media. These parameters are expected to be key indicators in determining whether injected CO_2 has or has not impacted groundwater quality either 1) directly by introduction of CO_2 into the St. Peter Sandstone or 2) indirectly by CO_2-induced migration of groundwater with differing chemical compositions (e.g., brine) into the St. Peter Sandstone.

Sample Containers

All sample bottles will be new. Sample bottles and bags for analytes will be used as received from the vendor or contract analytical laboratory or cleaned prior to use as appropriate for the analyte of interest.

Well Sampling

Groundwater pH, temperature, and specific conductance will be measured in collected samples in the field using portable probes consistent with standard methods (e.g., APHA, 2005). Field chemistry probes will be calibrated at the beginning of each sampling day according to equipment manufacturer procedures using standard reference solutions.

Samples will be filtered through 0.45 µm filters as appropriate and consistent with ASTM D6564-00. For alkalinity samples, efforts will be made to minimize exposure to the atmosphere during filtration, collection in sample containers, and analysis. Sample preservation techniques (Table F2-1) will be consistent with those described in US EPA (1974), American Public Health Association (APHA, 2005), Wood (1976), and ASTM Method D6517-00 (2005). After

collection, samples will be placed in ice chests in the field and maintained thereafter at approximately 4° C until analysis.

Table F2-1. Sample preservation and containers

ANALYTE	PRESERVATION[1]	HOLDING TIME[1]	CONTAINER[1]	METHOD
Alkalinity	Filtration, 4° C	In field, 14 days	HDPE bottle	EPA 310.1 APHA[2] 2320
Dissolved Anions: Bromide, Chloride	Filtration, 4° C	28 days	HDPE bottle	EPA 300.0 APHA 4110B
Dissolved Metals: Calcium, Sodium	Filtration, 4° C, HNO_3 < pH 2	6 months	HDPE bottle	EPA 200.8 APHA 3120B

Note 1: USEPA, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020
Note 2: American Public Health Association, Standard Methods for the Examination of Water and Wastewater

Sample Analysis

Sample analysis will be performed by a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory. Anion concentrations will be determined by ion chromatography (e.g. O'Dell et al., 1984, EPA Method 300.0), and cation concentrations will be determined by inductively coupled plasma (ICP) spectrophotometry, (e.g., EPA Method 200.8; APHA, 2005). Alkalinity will be determined using APHA Method 2320.

Quality Assurance/Quality Control (QA/QC)

Field quality assurance will primarily include the use of field duplicates and field blanks. One field duplicate and one field blank will be used per sampling event. Additional field QA/QC measures will be implemented according to ASTM Method D7069-04 (2004) as needed.

Sample Chain of Custody

All sample bottles will be labeled with durable labels and indelible markings. A unique sample identification number, sampling date, and analyte(s) will be recorded on the sample bottles as well as sampling records. Sampling records (e.g., a field logbook, individual well sampling sheet) will indicate the sampling personnel, date, time, sample location/well, unique sample identification number, collection procedure, measured field parameters, and additional comments as needed.

A chain-of-custody record shall be completed and accompany every sample or group of samples collected during an individual sampling event to track sample custody. This record should

include: sampler name(s), their affiliation, address, phone number, project identification and project location, sample(s) identification number(s), sampling date and time, signature of person(s) involved in chain-of-custody possession, and remarks regarding sample(s). Where appropriate, ASTM Method D6911-03 (2003) will be followed for packaging and shipping of samples. Immediately upon sample collection, containers shall be placed in an insulated cooler and cooled to 4 degrees Celsius. Samples will either be shipped or hand delivered. Shipment priority will be determined by the holding times or need to expedite sample analysis. Upon receipt at the laboratory, the samples will be accepted and tracked by the laboratory from arrival through completed analysis.

Groundwater Quality Evaluation

Data validation will include the review of the concentration units, sample holding times, and the review of duplicate, blank and other appropriate QA/QC results. All groundwater quality results will be entered into a database or spreadsheet. Copies of analytical data from the NELAP laboratory will be kept on file by the permit holder for the duration of the project. A summary of analytical results from the NELAP laboratory will be prepared to characterize general groundwater quality during pre-injection fluid sampling. That summary will then be available for water quality comparisons if subsequent sampling were conducted during the injection or post-injection periods.

F2.5. References

APHA, 2005, *Standard methods for the examination of water and wastewater (21st edition)*, American Public Health Association, Washington, DC.

ASTM, 2010, Method D7069-04 (reapproved 2010), *Standard guide for field quality assurance in a ground-water sampling event*, ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA.

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ASTM, 2005, Method D6452-99 (reapproved 2005), *Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations,* ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA.

Gibb, J.P., R.M. Schuller, and R.A. Griffin, 1981, *Procedures for the collection of representative water quality data from monitoring wells,* Illinois State Geological Survey Cooperative Groundwater Report 7, Champaign, IL, 61 p.

Larson, D.R., B.L. Herzog and T.H. Larson, 2003. *Groundwater geology of DeWitt, Piatt, and Northern Macon Counties, Illinois.* Illinois State Geological Survey Environmental Geology 155, 35 p.

O'Dell, J. W., J. D. Pfaff, M. E. Gales, and G. D. McKee, 1984, *Test Method- The Determination of Inorganic Anions in Water by Ion Chromatography-Method 300*, U.S. Environmental Protection Agency, EPA-600/4-84-017.

US EPA, 1974, *Methods for chemical analysis of water and wastes,* US EPA Cincinnati, OH, EPA-625-/6-74-003a.

Wood, W. W., 1976, *Guidelines for collection and field analysis of groundwater samples for selected unstable constituents*, In U.S. Geological Survey, Techniques for Water Resources Investigations, Chapter D-2, 24 p.